



Specification Amendments Filed 03/08/05 with Response to Office Action mailed by Examiner on 09/08/2004 in Patent Application No. 10/068,433

The paragraph on Page 4 beginning with Line 5:

In certain embodiments, gratings **170** and/or **180** have a narrow bandwidth to define the precise position of the wavelength λ_{s2} , within the allowed bandwidth of the second Raman Stoke shift. In some embodiments, at the wavelength λ_{s2} , Bragg grating **180** has a high reflectivity (e.g., about 100%), whereas grating **170** has a lower reflectivity (e.g., less than about 100%). Energy at wavelength λ_{s2} can circulate in fiber **140** by reflecting between gratings **170** and **180**. In some embodiments, WDM **130** is designed so that substantially no energy at wavelengths λ_{s1} and λ_{s2} is transferred from fiber **140** to fiber **120**. In these embodiments, energy at wavelengths λ_{s1} and λ_{s2} can repeatedly propagate in fiber **140** in both the clockwise and counter clockwise directions, thereby enhancing the intensity energy at λ_{s1} and λ_{s2} within fiber **140**.

The paragraph on Page 4 beginning with Line 29:

In some embodiments, such as, for example, when grating **180** has a high (e.g., about 100%) reflectivity, the energy at λ_{s2} , transferred from fiber **140** to fiber **192** through the WDM **190** is predominantly in a direction shown by the arrow in Fig. 1. In embodiments in which grating **180** does not have a high (e.g., about 100%) reflectivity there can be energy transfer from fiber **140** to fiber **192** at λ_{s2} in the opposite direction via WDM **190**. In these embodiments, energy at λ_{s2} is transferred from fiber ~~**120**~~ **140** to fiber **192** via WDM **190** in both directions. Fiber **192** optionally includes a fiber Bragg grating **194** designed to substantially reflect energy at wavelength λ_{s2} , thereby allowing the majority of the energy at λ_{s2} , transferred to fiber **192** from fiber **140** to ultimately propagate through fiber **192** in one direction.

The paragraph on Page 6 beginning with Line 1:

In certain embodiments, the path of pump energy propagation is as follows. After passing device 160, pump energy λ_p propagates through fiber 120 until it encounters WDM 130, then at least a portion of the pump energy is transferred to loop-shaped fiber 140 and propagates therethrough in the clockwise direction. When the pump energy reaches WDM 130 it can be transferred to fiber 120 and propagate toward WDM 135. WDM 135 transfers at least a portion of the pump energy from fiber 120 to loop-shaped fiber 145, where the pump energy propagates in the clockwise direction. The pump energy can be transferred from fiber 145 to fiber 120 via WDM 135 and propagate toward the grating 150. Grating 150 substantially reflects the pump energy, resulting in propagation of the pump energy in the opposite direction. This also results in counter clockwise propagation of the pump energy in fibers 145 and 140. The residual pump energy that is not converted into Raman shifted signals can be terminated (e.g., removed from system 200) via device 160.

The paragraph on Page 8 beginning with Line 12:

Fig. 4 shows a cascaded laser system 301, including an optical circulator 162, a fiber 312, a WDM 362, Bragg gratings 322 and 332, a coupler 307 (e.g., a broadband coupler, such as a broadband 50% x 50% coupler), a loop-shaped fiber with Raman active material 317, a fiber 366 and a terminal broadband reflector 152. In certain embodiments, some or all of these elements can be similar to those described above with respect to system 300. In some embodiments, the optical circulators can be used as follows. Circulator 160 directs pump energy into the first Raman cascade and then it redirects the backward propagated energy toward the optical circulator 162. Optical circulator 162 directs pump energy into the second Raman cascade and then redirects the backward propagated pump energy into optical ~~loss~~ bath for disposal or it can direct it to the next cascade. The number of cascades can be more than two. Each cascade can generate its own wavelength λ_{s2} , (e.g., the first cascade - $\lambda_{s2'}$, the second - $\lambda_{s2''}$ etc.). Energy at these wavelengths can be transferred via the respective WDMs 360, 362 etc. The WDMs can be connected with the common fiber 390 and provide the combined set

of wavelengths $\lambda_{s2'}$, $\lambda_{s2''}$ etc. at its terminal end. Intensities of energy at the latter wavelengths can be regulated via coupling efficiencies of the output couplers.

The paragraph on Page 8 beginning with Line 27:

Fig. 5 is a schematic view of a Raman fiber laser system **400** including an energy source **110** and a fiber **120**. Fiber System **400** includes pairs of fiber Bragg gratings (**410/415**, **420/425**, **430/435**, **440/445**, **450/455**) and a Bragg grating **150**, which has a high (e.g., about 100%) reflectivity at the pump wavelength λ_p . The fiber Bragg gratings within any particular pair can substantially reflect energy at the same wavelength. For example, gratings **410** and **415** can substantially reflect energy propagating in fiber **120** at the first order Raman Stoke shift λ_{s1} . Certain pairs of gratings (e.g., **430/435**) are arranged so that there are no dissimilar gratings therebetween. With this arrangement, energy propagating in fiber **120** at the wavelength reflected by these gratings is confined to the region in fiber **120** between the gratings (e.g., **430/435**). If desired, a coupler can be included in system **400** so that energy at this wavelength can be transferred from fiber **120** (e.g., to an optical fiber for pumping).

The paragraph on Page 10 beginning with Line 10:

Fig. 6 shows a schematic of system **500**. The tandem grating pairs (**420/425**, **430/435**, **440/445**, **450/455**) can all have, for example, a high (e.g., about 100%) reflectivity at certain wavelengths (e.g., $\lambda_{s2'}$, $\lambda_{s2''}$, $\lambda_{s2'''}$, $\lambda_{s2''''}$, $\lambda_{s2'''''} \dots \lambda_{s2''''''}$). Energy transfer at wavelengths $\lambda_{s2'}$, $\lambda_{s2''}$, $\lambda_{s2'''}$, $\lambda_{s2''''}$ is conducted via WDM **424**, **434**, **444**, **454**, respectively, disposed between corresponding gratings and connected with fiber **180**. The coupling efficiencies of the WDMs can be substantially less than 100% and can be appropriately set to obtain a predefined intensity distribution of output energies at the wavelengths $\lambda_{s2'}$, $\lambda_{s2''}$, $\lambda_{s2'''}$, $\lambda_{s2''''}$ (e.g., a substantially flat intensity distribution at these wavelengths). In some embodiments, one of the terminals of fiber **180** can optionally have reflector **470** and/or reflectors **472**, **474**, **476** that would facilitate the delivery of output energy to the right side terminal of the fiber **180**. In certain embodiments, system **500** can have two

output ports for energy at wavelengths $\lambda_{s2'}$, $\lambda_{s2''}$, $\lambda_{s2'''}$, $\lambda_{s2''''}$ through the left and right terminals of fiber 180.